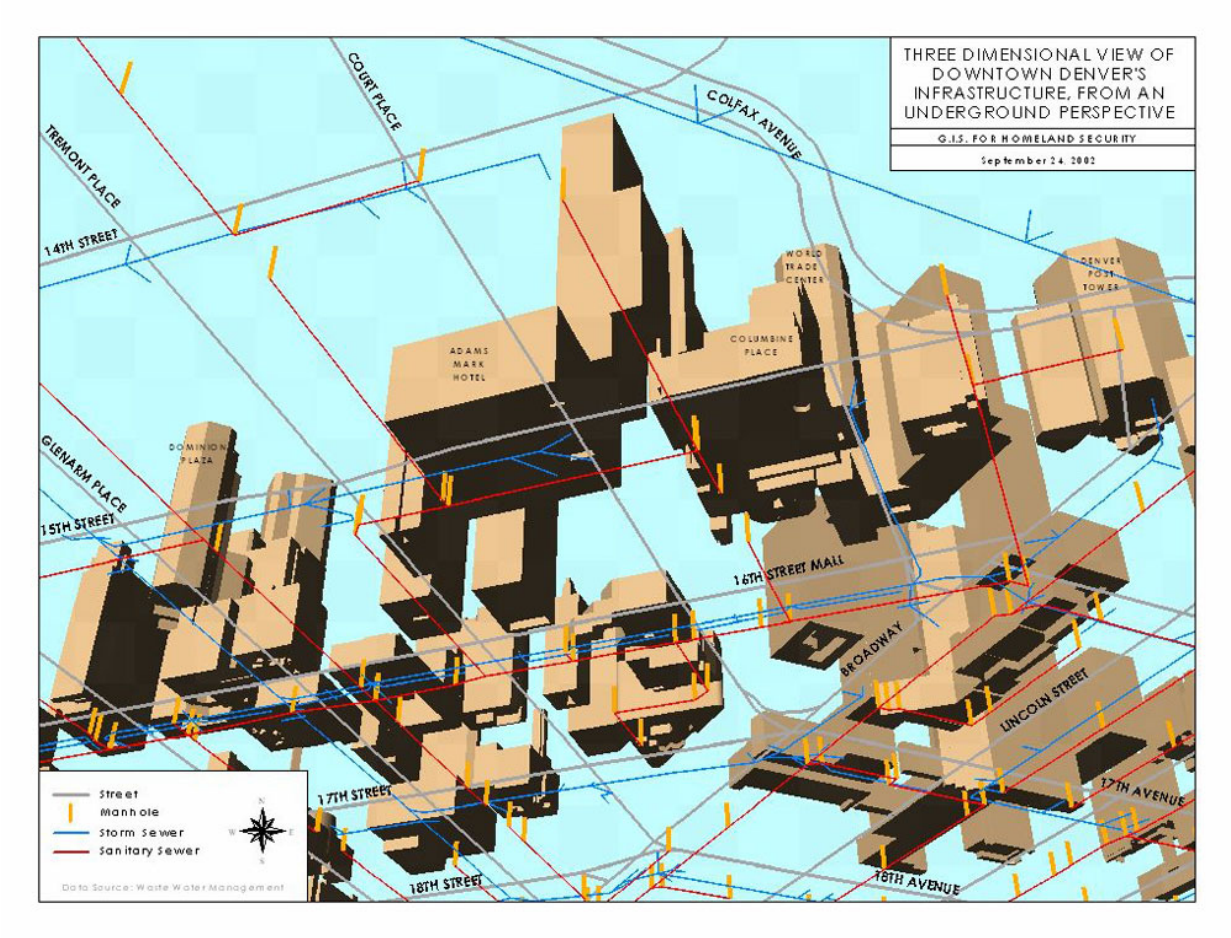

Using GIS to Support Emergency Management and Homeland Security

pti **Public Technology Institute**
The technology resource for local governments

This publication was produced by the Public Technology Institute (PTI), a national member supported organization based in Washington, DC. As the only technology organization created by and for cities and counties, PTI works with a core network of leading local government officials- the PTI membership - to identify opportunities for technology research, share best practices, offer consultancies and pilot demonstrations, promote technology development initiatives, and develop enhanced educational programming. Officials from PTI member governments participate in councils and forums that address specific technology areas. Through a corporate partner program with leading technology companies, and partnerships with federal agencies and other governmental organizations, PTI shares the results of these activities and the expertise of its members with the broader audience of the thousands of cities and counties across the U.S. For additional information see the PTI web site at www.pti.org.

Dear Local Official:

PTI is pleased to provide you with the second edition of *Using GIS to Support Emergency Management and Homeland Security*. The first edition was released in the fall of 2005, just after hurricanes Katrina and Rita devastated much of the southeastern portion of the United States. Since then, much has been learned about the role Geospatial (or Geographic) Information Systems (GIS) technology can play in emergency preparedness efforts and disaster response.

This second edition will help local officials explore ways to build proactive and collaborative approaches between agencies responsible for emergency management and those that collect and maintain geospatial data.

This document highlights how several local governments have developed effective strategies for GIS and emergency management collaboration to improve emergency management planning and response within their communities.

As you read through this document, I encourage you to consider how the examples provided can be applied in your community.

Sincerely,

Alan Shark, D.P.A., CAE
Executive Director

December 2006

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Introduction

The new and updated case studies in this second edition continue to confirm that cities and counties are turning to their enterprise GIS systems to support homeland security efforts, and that local emergency managers are welcoming GIS into their agencies. We are also finding that U.S. Department of Homeland Security support continues for local enterprise-GIS systems when those systems are linked to emergency management functions.

The first edition of this publication was issued immediately following Hurricane Katrina. We now suspect that fully "operationalized" geospatial information about the location of vulnerable populations, the condition of critical infrastructure, and structure elevation compared to potential flood levels, might have provided valuable support to response and rescue operations in the immediate aftermath of the storm. This recognition lends more urgency to the incorporation of geospatial capabilities into local emergency management operations.

An additional trend to note is the growing movement to develop regional GIS systems, usually centered around major cities and urban counties. The Department of Homeland Security, states and local governments recognize that emergencies don't stop at administrative borders and information and operations, to be fully effective, must be organized across multi-jurisdictional areas. An added bonus of regionalizing GIS data and systems is the support that can be provided to economic development, environmental, and transportation planning and management efforts.

Looking ahead, the next stage in the evolution of this document could be an exploration of how geospatial data, systems, and technologies are being used by PTI member jurisdictions to design the CONOPS (concept of operations) necessary to achieve situation awareness and a common operating picture during emergency operations. Additionally, we can explore how the use of exercises, simulations, and war gaming can help to test and refine existing emergency plans.

Please let us know whether this document is of use to your efforts and what areas of concern and opportunity should next be addressed. Also, please consider providing a case study of your own so that our entire local government community can learn from your experiences.

Background

The effectiveness of geospatial systems in support of public safety, emergency preparedness, and disaster response has, by now, been well established and well documented through its use following the 9/11 terrorist attack, the Shuttle disaster, hurricanes, western wildfires, and countless other regional and local disaster operations. Disaster management experts almost universally agree that robust information assets – especially those that are geospatially oriented and integrated – are essential for adequate disaster and emergency planning, mitigation, response, and recovery. In short, geospatial systems help save lives.

Although many cities and counties are developing robust enterprise geospatial systems, in some cases, Geospatial/Geographic Information Systems (GIS) managers experience difficulty convincing their offices of emergency management (OEM) to adopt and adapt these systems for their own use. Some OEMs opt to build their own independent GIS systems while in other jurisdictions, OEM managers may not appreciate the power of integrated, spatial data – preferring a more traditional approach to emergency management dominated by an emphasis on boots, suits, equipment, and communications. While such hardware-oriented acquisitions strengthen local capabilities, without the matching information and intelligence to guide their use, their effectiveness can be limited. In either case the failure of GIS and OEM personnel to fully collaborate weakens preparedness efforts. There are also many jurisdictions that have not yet started down the often long and difficult road to building an enterprise GIS system. The OEMs in these cities and counties cannot therefore benefit from these critical systems.

The U.S. Department of Homeland Security (DHS), in its efforts to strengthen local and state preparedness, has offered generous grants through individual state departments of homeland security. Initially, grant-enabling language at DHS did not provide for the funding of GIS assets and systems. Today, DHS grants provide for the acquisition of such resources, albeit with significant constraints, but it is up to individual state and local managers to determine what percentage of funds – or whether any funds at all – will flow toward such acquisitions. Since emergency operations managers are often far more influential than their IT and GIS counterparts, where “geospatial consciousness” is not sufficiently present, little funding is likely to flow toward GIS systems development.

This document begins the process of building an archive of case studies from local jurisdictions that detail instances where GIS and OEM professionals are working successfully to build information and intelligence capabilities to support emergency operations. By citing effective collaboration strategies, best practices, and successful results – while not shying away from problem areas – PTI hopes to encourage other local governments to adopt balanced disaster management strategies that include the development of robust enterprise geospatial capabilities.

GIS and Emergency Management
City of Chicago, Illinois

Background

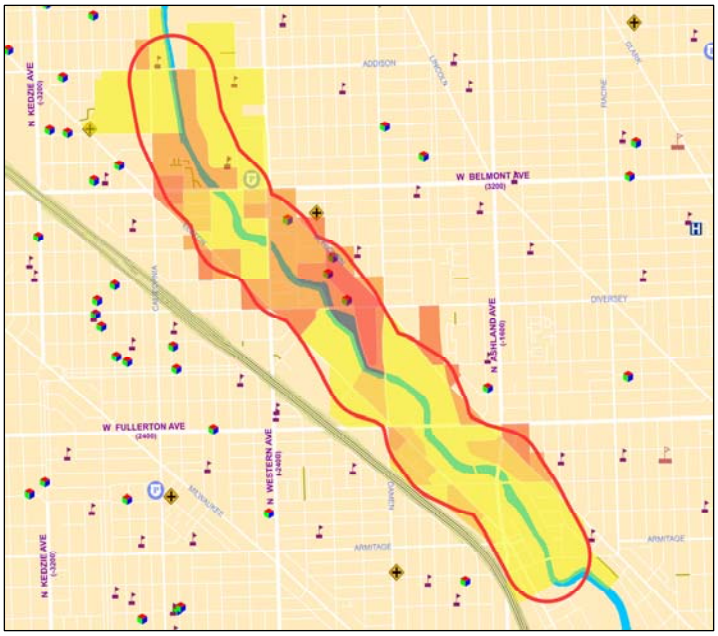
In the City of Chicago, the Office of Emergency Management and Communications (OEMC) manages emergency preparedness and response activities in coordination with first responder departments Police, Fire, Environment, and Public Health. Chicago's enterprise Geographic Information Systems (GIS) unit is a division of the Information Technology department (Department of Business and Information Services). The GIS Division supports all 50 city departments with geodatabase management, toolsets, and application development.

While Chicago's GIS has many data sources and tools that can assist in an emergency, formal collaboration did not exist until the OEMC approached GIS to implement the Federal Emergency Management Agency's (FEMA) HAZUS tool, to generate incident impact statistics. A review of the HAZUS tool identified a number of limitations that would discourage widespread use at the city. GIS and the OEMC embarked on developing a server-based application that could leverage up-to-date enterprise data and simultaneously serve multiple departments.

Strategy

The city developed the Alert Chicago Emergency toolkit, known as ACE, with the following principles in mind:

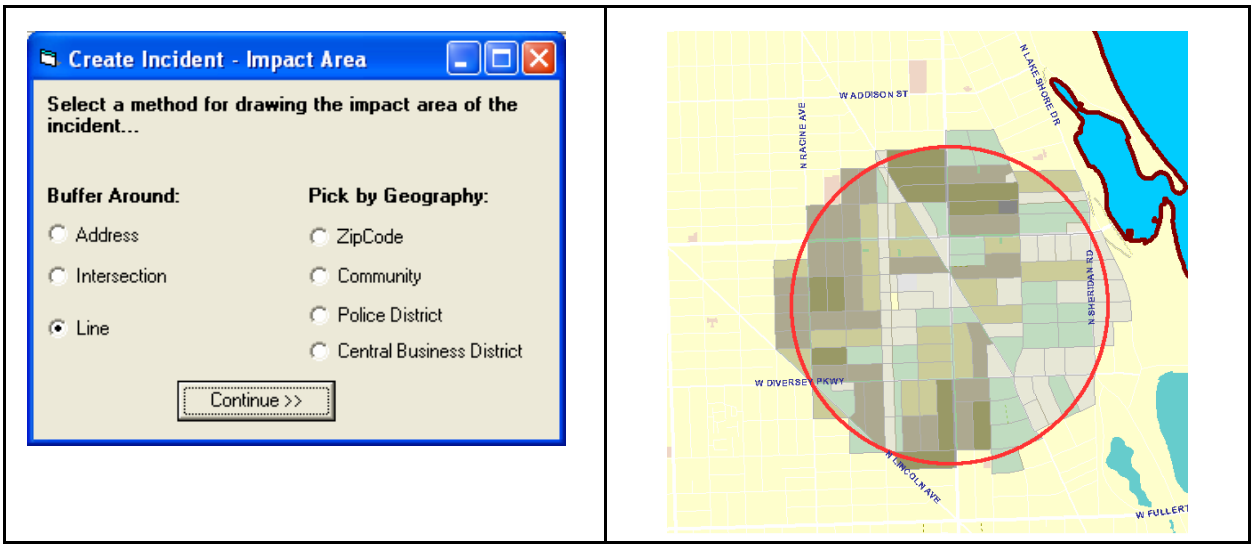
- Implement a data architecture that supports both the FEMA
- tool and shared emergency management application needs.
- Integrate the data architecture with facility and infrastructure data already managed by the city.
- Develop an application to maintain a central repository of critical facilities and special use attributes.
- Develop end-user tools to generate response-focused tools and reports rather than just projected damage estimates.
- Integrate the impact data with interactive, browser-based tools for emergency management.



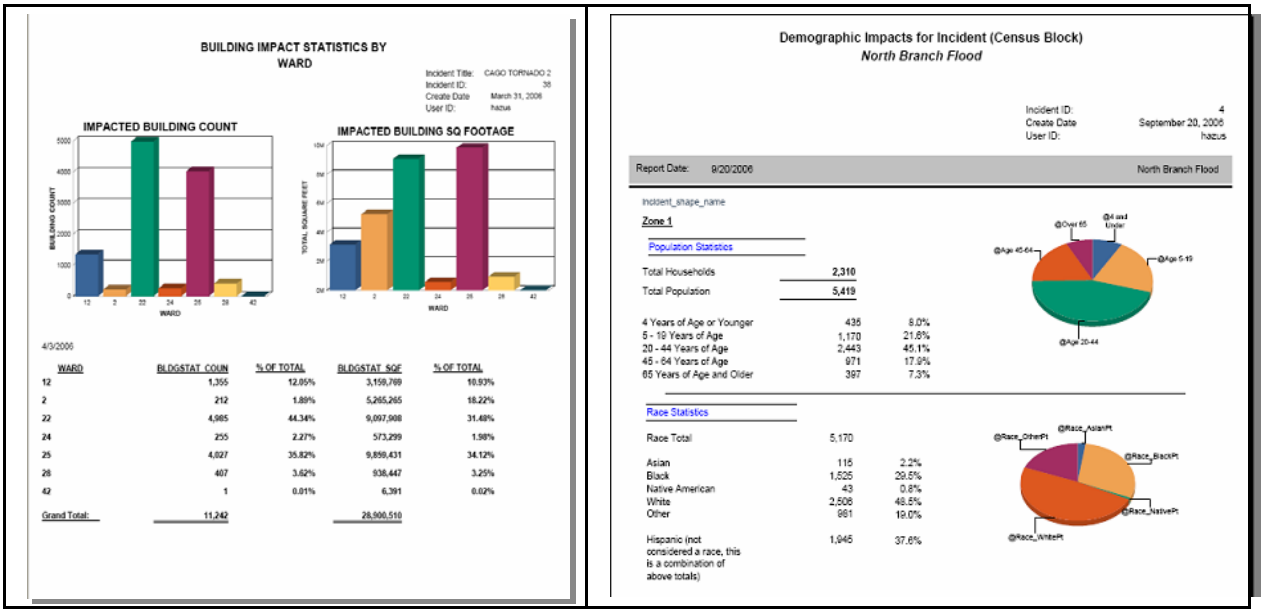
Sample of flood incident area with building density

ACE Application

The ACE application is designed for use by first responders without specialized GIS training. The user can identify the area of impact and view various spatial impact factors by building count, building density, and demographics.

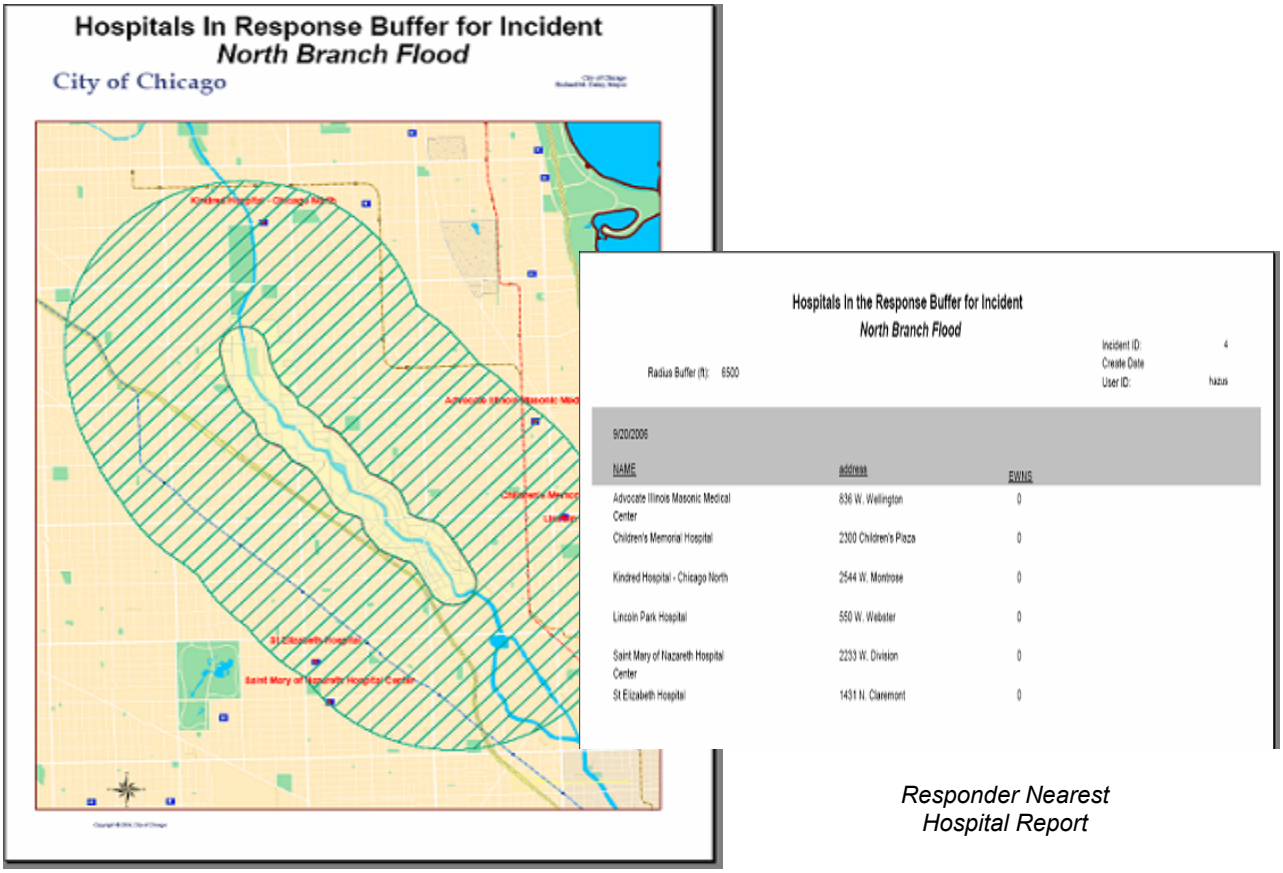


Incident Creation



Impact Reports

Responder Reports map and list the closest hospitals, police stations, or other locations of interest. Advanced functions allow the import of plumes created by other modeling applications. Aggregate analysis of multiple incidents with similar characteristics is also supported.



Responder Nearest Hospital Report

ACE Data Architecture and Rollout Plan

ACE maintains cross references and statistics tables that map buildings and other critical elements to census blocks. Editor tools for these base layers automatically maintain the cross reference and statistics. This allows impact statistics to be derived based on the census blocks that fall within an impact area.

The model maintains a log of every incident, along with its related shapes and census blocks. Future releases will also track response logs, with associated shapes that will be able to playback the incident response. End users will be able to track road blocks, deployments, evacuation routes, and other activities in the application.

ACE is currently a desktop tool accessing an enterprise server database. The OEMC, Fire, Health, and Environment departments have served as beta testers. The first production release is scheduled for January 2007 and will include enhancements to support electrical outage reporting for the Department of Environment. A browser-based application will follow, along with integration with GPS and work order systems.

Contributed by Molly Mangan, GIS Director, City of Chicago.

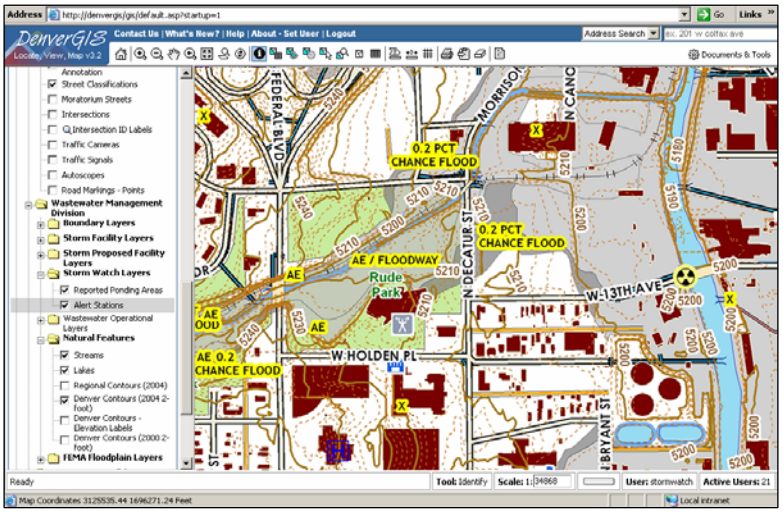
Integrating GIS Technology with Emergency Management Situations City and County of Denver, Colorado

Introduction

The Denver Office of Emergency Management, police, fire, and first responders rely on accurate geographic information provided by Denver's Geographic Information Systems (DenverGIS) for their planning and emergency response needs. GIS provides emergency managers, department directors, city council, and the mayor with easily accessible data, maps, and statistical analysis before, during, and after an event. Leveraging a prodigious inventory of critical infrastructure, assets, and hazard information collected from multiple sources ranging from aerial photography to maps, charts, and documents enable the GIS team to answer a myriad of planning and response questions to protect life, property, and ensure the delivery of services. Spatial layers such as parcels, population density, buildings, streets, and aerial photography are routinely used to provide a 'real-world' context for planning, tactical deployment, and communication.

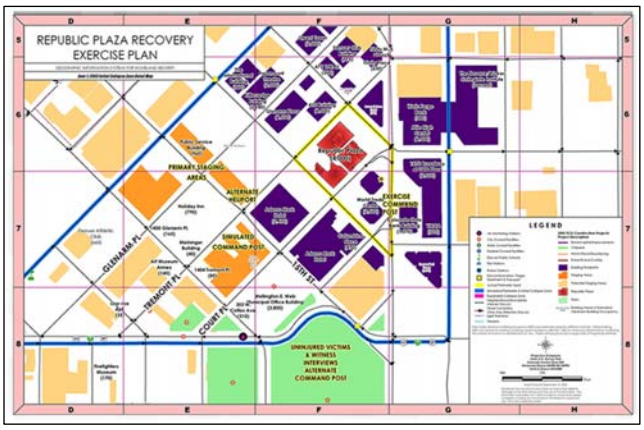
Applications

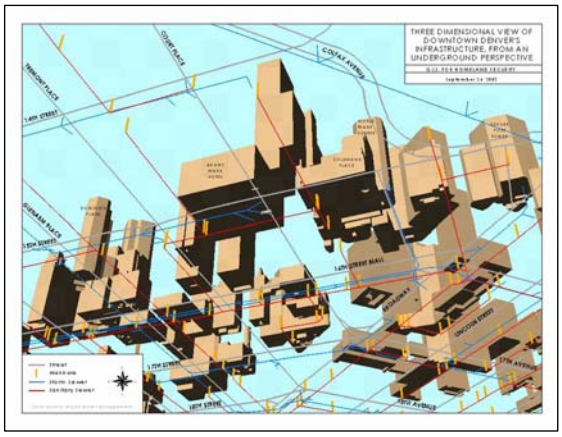
GIS applications, such as Denver's Storm Watch, were developed in-house by the DenverGIS staff using the ESRI ArcIMS software to enable multiple departments and regional authorities the ability to evaluate flood zones, monitor real-time stream flows, and associated risks to infrastructure and populations. Emergency managers identify areas of vulnerability, view response scenarios, and develop action plans during the flood and tornado seasons that Denver experiences every year. The results are also used to develop capital improvement programs and obtain funding to address safety and aging infrastructure concerns.



GIS provides a common operating picture for the region and situational awareness support during an event. Integrating GIS data with vendor solutions extends the GIS information into the computer-aided dispatch (CAD) system, automatic vehicle location (AVL) and mobile data terminals within police, fire, and emergency medical vehicles.

Intergovernmental agreements for GIS data sharing and support services have been established with local, state, and federal entities, and private partners. Denver's involvement in the 10-county Urban Area Security Initiatives (UASI) has ensured that channels of communication remain open, efforts are coordinated, and data standards are adhered to in order to promote interoperability. This information is routinely used in local and regional tabletop training exercises to field-test equipment and response plans. The outcome from these exercises ensures that Denver and its regional partners are coordinated and prepared in their response.





Providing information to the public through established local and state communication channels, which include Denver's 311 and the State of Colorado's 'Ready Colorado' program, is part of the multi-channel communication strategy employed by DenverGIS. Striving to incorporate Section 508 Federal Accessibility requirements into this notification system and pre-identifying 'at-risk' populations ensure that this percentage of the population is informed and effective assistance is provided.

Keys to Success

A number of factors have played a key role in effectively integrated GIS technology into emergency management operations. These include:

- Assess needs and capture opportunities to apply GIS visualization technology,
- Build proactive and collaborative teams between departments and jurisdictions,
- Integrate spatial and non-spatial information for situational awareness (SA),
- Train GIS staff in the Incident Command Structure (ICS),
- Deploy GIS staff and applications at all events and training exercises,
- Integrate GIS with dispatch, work orders, and constituent relationship management applications,
- Apply an enterprise approach to information management,
- Develop a Regional Homeland Security GIS Strategic Plan.

Conclusion

Geographic information has become an essential tool for planning and recovery exercises and has proven to be a valuable asset during an emergency. Using existing GIS data, pre-printed map books and related resources, GIS staff can quickly map out

the extent of the incident and prepare analysis maps about affected areas for public information officers and incident command staff while providing timely information to first responders.

Contributed by David Luhan, GIS Manager, Technology Services – DenverGIS, City and County of Denver.

The City of Fort Worth's Continued Success in Emergency Management & GIS Integration
City of Fort Worth, Texas

In 2002, discussions began within the City of Fort Worth's emergency management community regarding ways to utilize geospatial technology to support the needs of emergency preparedness and response. Once the City's GIS staff began meeting with emergency planners and responders, several keys issues were identified in integrating emergency management and GIS. By 2003, the following integration components were successfully implemented: response protocol, standardized maps, emergency planning, continuity in data gathering, and data analysis and visualization. Over the last 3 years GIS has proven to be effective in both real-world emergency response and preparedness. Furthermore, the GIS support has been so beneficial that funding has been made available to enhance the emergency management and GIS integration capabilities.

REAL-WORLD RESPONSE

Valley Solvent and Chemical Company Fire

On July 28, 2005, at 1:30 p.m., City of Fort Worth Police and Fire were dispatched to 2573 NE 33rd Street in response to a reported explosion and fire at Valley Solvent and Chemical Company. The Fort Worth – Tarrant County Emergency Operations Center (EOC) was activated and requested support from the GIS Mapping Team to model the chemical plume from the fire and resulting explosions.

Using technology developed and supported by the National Atmospheric Release Advisory Center (NARAC) at Lawrence Livermore National Laboratory and through Fort Worth's participation with the PTI pilot program "Local Integration of NARAC with Cities" (LINC), the capability of staff to respond in a timely and informed manner to an accidental atmospheric release was greatly enhanced. NARAC staff not only helped refine the chemical plume model, but also derived a smoke plume model so that smoke impacts could be taken into account when advising the public. While the original shelter-in-place boundaries were defined by field observations of the weather and smoke plume, the final recommended shelter-in-place area was redefined following the compilation of data and the plumes refined by Fort Worth and NARAC staff. Model reports and projected impacts were useful in the determination of evacuation and shelter-in-place recommendations, road closures and traffic planning, spill containment, and potential runoff areas.

Hurricane Katrina

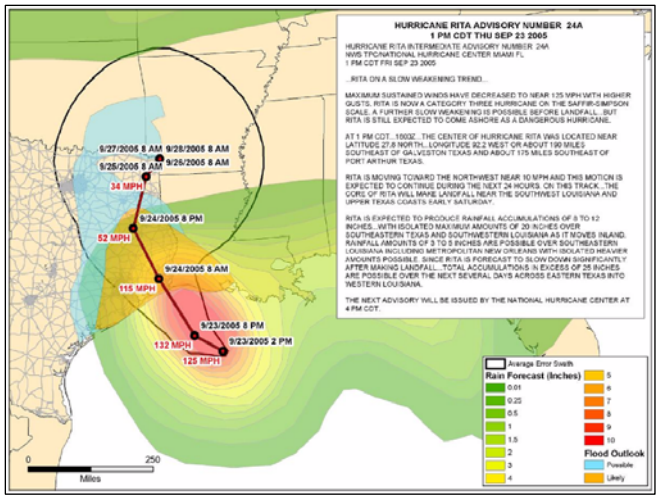
Hurricane Katrina hit the Gulf Coast on August 29, 2005. The Category 4 hurricane created damage from Louisiana to Florida, and hundreds of thousands of people fled the area toward Texas cities. The Fort Worth – Tarrant County EOC was activated the week following the hurricane to assist Katrina survivors. Shelters were open across Tarrant County and many of the survivors were left with nowhere else to go. The City stepped up to provide assistance to the new guests in Fort Worth.

The GIS Mapping Team provided assistance to the EOC for several months following the event. Maps were provided to EOC and operations personnel showing shelter locations. Throughout the event these shelter maps were updated on a regular basis showing shelters, apartments, and hotels. EOC and City officials used this information to coordinate shelter logistics. As the guests were moved from shelters into apartments and hotels, community service maps showing conveniences such as groceries, pharmacies, and bus routes were generated. The support activities following Hurricane Katrina stand as the longest running event since the creation of the GIS Mapping Team.

Hurricane Rita

Hurricane Rita hit the Louisiana and Texas coast on September 24, 2005, and was anticipated to hit the Texas coast and travel north through the Dallas – Fort Worth metroplex with Category 1 winds. The GIS Mapping Team started to prepare in anticipation of the hurricane and the additional guests that this storm might bring to the metroplex.

The path of the hurricane was tracked utilizing HURREVAC, a hurricane decision assistance and planning tool specifically developed for government emergency management. The FEMA- and NOAA-supported software provides official forecasts of flood outlook, precipitation, swath, and wind speeds of the hurricane from the National Hurricane Center. Maps illustrating these impacts were generated for each hurricane advisory (typically every 3 hours) and were distributed to the EOC and operations personnel. HAZUS-MH MR1 software from FEMA was utilized to predict the potential impacts of hurricane-force winds and flood-prone areas. This software integrated with the City's existing GIS software to make the most accurate predictions possible, focusing on natural disasters. Both the hurricane and flooding models were run for the Fort Worth area using the HAZUS-MH MR1 software. It was ultimately determined, based on the path outlined in the HURREVAC software and the resulting HAZUS-MH MR1 models, that the physical impacts from Hurricane Rita would be minimal.



HURREVAC Forecast for Hurricane Rita

REAL-WORLD PREPAREDNESS

Landmark Tower Implosion

During a March 28, 2000, tornado, the Landmark Tower Building, located in downtown Fort Worth, suffered significant damage. The building had gone through several owners throughout the years, and plans, at one time, were to convert the skyscraper to luxury apartments and condominiums. The project fell into bankruptcy and the building was purchased in January 2004 by XTO Energy. The company explored all options to restore the building but finally determined the best course of action was to tear it down. In October 2005, demolition permits were acquired, and the pre-implosion preparation work began.

Although the Landmark Tower Building stood on its own city block, it was nestled within the core of the central business district and bordered one of the City's premier entertainment districts. It was also to be one of the world's tallest buildings to be imploded at about 407 feet tall. The City of Fort Worth took the opportunity to incorporate the plume modeling tools of NARAC into the public safety preparedness of the March 18, 2006, implosion event.

Weeks prior to the actual event, NARAC personnel worked closely with the City to model an explosive dispersion plume utilizing National Weather Service forecast data. Research into standards for plume modeling of implosions, and estimates of building percent compositions and materials was also completed. Overall, the NARAC proved to be a useful planning tool for modeling particulates resulting from this implosion. Forecast models of the particulate plume and its potential impacts were useful in determining pre-evacuation, traffic plans, staging areas, road closures, and public safety posts.

Landmark Tower Implosion Plumes – actual vs. model

FUNDING SUCESSES

Planimetrics

The Office of Emergency Management (OEM) is responsible for disaster planning and response for the City of Fort Worth and portions of Tarrant County. The City of Fort Worth is the nation's 20th largest city with the majority of the city falling within Tarrant County.

The U.S. Census Bureau reports that Fort Worth's population increased by 8.1% between April 1, 2000, and July 1, 2003, making it the nation's fastest-growing large city. Although the Metroplex is continually changing, acquiring a current snapshot of the city would greatly benefit the City's Metropolitan Medical Response System (MMRS) efforts.

Planimetrics is the creation of geographic features based on recent aerial photography such as building footprints and road edges. The North Central Texas Council of Governments (NCTCOG), through the aerial photography cooperative program, will be acquiring this data in early 2007. Utilizing this program will create a great starting point for the maintenance of this data in the future. An investment will prove to be long-term, as planimetric data will provide the capability of Site Selection and Multi-modal Transportation modeling:

- *Site Selection*

Planimetric datasets of buildings, parking lots, and road edges will assist in identifying locations of staging areas. In medical response, staging areas of command centers, decontamination areas, pharmaceutical dispensing, shelters, and triage need to be strategically identified. These sites need to be selected based upon defined criteria such as square footage, proximity to roads, and/or the availability of open space.

- *Multi-modal Transportation*

Geographic features of bridges, buildings, fences, road edges, and sidewalks will enhance the existing street data layer into functional geometric transportation network. With the creation of such a network, efficient routes can be delineated between the location of emergencies and command centers, decontamination areas, pharmaceutical dispensing, shelters, and triage. Providing other datasets such as fences and sidewalks will enable non-street routes to be identified so that masses of people could be directed across the landscape.

GIS Workstation

In the past, the EOC had only one computer allocated to support not only GIS functions, but administrative, emergency briefings, and personnel support as well. During actual emergencies, emergency management staff primarily used the computer. Therefore, GIS support had been provided through other machines off-site. This, however, created a disconnection between GIS and EOC personnel by increasing the time of data requests and fulfillments. Therefore, acquiring a computer that would be designated for GIS support was vital.

The standard GIS software utilized by the City is Environmental System Research Institute's (ESRI's) ArcGIS, which is an integrated collection of GIS software products for building a complete GIS. ArcGIS enables users to deploy GIS functionality wherever it is needed in desktops, servers, or custom applications over the Web or in the field. The software has a list of hardware requirements to run efficiently. Furthermore, the amount of data processing during an emergency requires specific hardware.

Therefore, a high-end GIS workstation was purchased through MMRS funding to be solely designated to GIS efforts within the EOC.

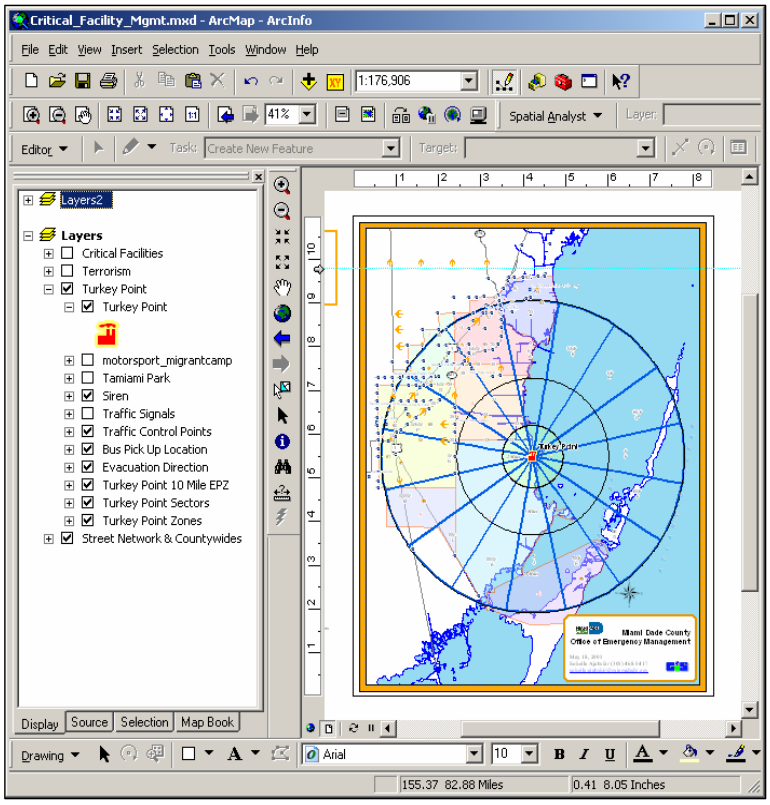
GIS Analyst Position

The EOC is identified under an existing NCTCOG Mutual Aid agreement to coordinate regional resources in emergency or disaster situations. In addition, the EOC is currently involved with programs under the DHS such as the Urban Area Security Initiative (UASI). A UASI grant proposal was submitted and approved to acquire a GIS Analyst position for the City's OEM. The primary duties of the newly created position include support for emergency preparedness and planning for all departments and regional agencies that utilize the EOC; creating, updating, and maintaining critical GIS base layers that are pertinent to public health and safety; and emergency response to aid in data gathering and dissemination.

Contributed by Betsi Chatham, Senior GIS Analyst, Environmental Management, City of Fort Worth and Robin Britton, Senior GIS Analyst, Information Technology Solutions, City of Fort Worth.

Use of GIS in Emergency Management Situations
Miami-Dade County, Florida

In many emergency situations like tornados, wild fires, and hazmat spills, the need to get locations of nearby critical facilities, such as schools, daycare facilities, and residential healthcare facilities, is essential. This enables emergency management officials to make appropriate decisions to protect the public. Information about population numbers and types in an affected area is essential to making effective decisions about possible evacuations, road closures, sheltering in place, or other protective actions. This information must be specific, accurate, and easily communicated.



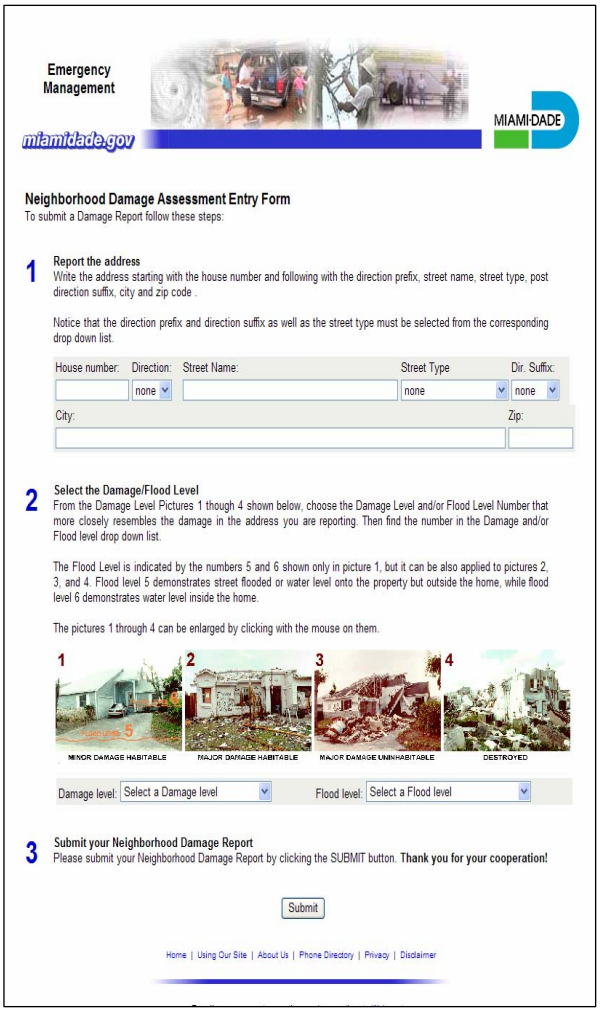
An ArcGIS application, Critical Facility Management, is used by the Miami-Dade Office of Emergency Management (OEM) in emergency situations to gather that data. In minutes, a map with pertinent critical facility information can be e-mailed to the appropriate response agencies. The GIS application has a direct link to all of the critical layers. These layers are updated by different county departments on a continual basis to ensure accurate data.

The following steps illustrate how the application works:

- Identify the incident location,
- Draw a plume around the incident,
- Activate all essential layers including residential population and employment population,
- Highlight/select all facilities within the selected radius,
- Export data to an existing Access application,
- Click to open the reports,
- Print/e-mail the map and the reports.

Using GIS technology, OEM also created a damage assessment application that enables residents to provide a quick overview, or snapshot, of damage after a hurricane, tornado, flood, or other event that could cause major damage. Immediately

following an event, residents are encouraged, through previous education and media advisories, to go to OEM's web page, to enter their address, and to identify the type of property damage sustained by looking at four pictures of damaged homes that most closely resembles the damage to their property (see graphic).



Timely data received in this manner enables Emergency Operations Center (EOC) staff to prioritize deployment of appropriate resources and to gain a quick overview of initial damage. If the Internet is unavailable, residents can report damage by telephone to an already established and widely publicized call center number that relays the information to the EOC. By using ArcIMS/ArcSDE, the captured geocoded location enables damage mapping to be used by EOC staff for planning purposes and more informed decision-making. This application was used during the active 2004 hurricane season and tested prior to the season during various drills.

GIS and OEM Mutual Support

The Miami-Dade County OEM has a dedicated, full-time GIS administrator as part of its staffing. GIS applications are used by emergency management staff on a daily basis in all phases of emergency management from preparation and mitigation through response and recovery.

Like the rest of OEM staff, this person has a dual role. During times of non-activation, the GIS Administrator works closely with emergency management programmatic staff to create maps, to provide data, to enhance existing systems and applications, and to develop new applications based on the many, varied programmatic needs. During activation, the GIS function is staffed around the clock to provide accurate, real-time data and maps as part of the response and recovery phase.

There are several applications utilized by OEM staff on a daily basis. These applications were created using the geo-coding capability of ArcGIS in combination with Microsoft Access and SQL server:

- Vulnerability Assessment,

- Residential Healthcare Facilities,
- People with Special Needs (PSN),
- Turkey Point Nuclear Facility,
- CERT (Community Emergency Response Team),
- Hurricane Shelters.

On a regular basis, OEM staff updates or adds appropriate information using the above applications, which are linked directly to ArcGIS for spatial analysis, mapping, etc. The geospatial capabilities of this data are used in all phases of emergency management as well.

The *Vulnerability Assessment* application is a combination of personal geodatabase and ArcGIS.

The *Residential Healthcare Facilities* application is a combination of personal geodatabase and ArcGIS.

The *PSN* application is a combination of geodatabase, map object, SQL server, and ArcGIS/ArcMap.

The *Turkey Point* application is a combination of ArcGIS model builder to get updated populations, personal geodatabase, and ArcGIS.

The *Hurricane Shelter* application is a combination of personal geodatabase and ArcGIS.

Funding and GIS support for Disaster Preparedness and Emergency Response

The Miami-Dade County OEM applied for and received ESRI's Homeland Security grant money for GIS software in 2003. In addition, the OEM applied for and received GIS software/hardware applications on the Metropolitan Medical Response System (MMRS) grant for the years 2003, 2004, and 2005.

The OEM would like to thank Miami-Dade County and the Miami-Dade County Enterprise Technology Services Department for their support.

Contributed by Soheila Ajabshir, Senior Systems Analyst, GIS Coordinator, Miami-Dade County Office of Emergency Management.

A Cooperative Approach to GIS and Emergency Management
City of Sacramento, California

Introduction

Geographic information systems (GIS) databases have been used for decades in the Sacramento region to help institutions and businesses at the local, state, and federal levels collect and analyze information to assist in better decision-making. Sacramento area jurisdictions with varying degrees of resources cooperate effectively with respect to organization, maintenance, and dissemination of digital spatial information for emergency operations, preparedness, response, and post-event management.

There are four major areas that view GIS as playing a key role in the delivery of essential public safety services. The four (highlighted in this report) are the following:

- Regional GIS Coordination,
- 911 Call Taking, Dispatch and Reverse 911,
- Flood Plain Management,
- Emergency Operations Center Support.

Sacramento's cooperative efforts combine daily and event-driven activities to address actual real-world situations regarding public safety and emergency response.

Regional GIS Coordination

In 2000, member jurisdictions within Sacramento County formed a GIS Cooperative with the Sacramento Area Council of Governments to more effectively support the broad use of and increased reliance on GIS in the region. The Sacramento Regional GIS Cooperative strives to minimize the duplication of digital data, to transfer technology, exchange data, to develop standards, and to share resources in completing joint interagency projects.

The Cooperative forms the framework for participating agencies and organizations to coordinate the development of GIS in Sacramento County. The Cooperative members participate in shared maintenance processes and use joint standards to manage parcel and street centerline basemaps for Sacramento County.

A web-based portal, funded by a grant from the Sacramento County Office of Emergency Operations, is used to coordinate and facilitate the shared maintenance of centerline and parcel base data. In later phases, the Cooperative intends to build a coordinated information management and distribution service that will be used by local governments for all phases of public safety planning. Phase two will collect unit address information and details about multiple units in single parcels. The project's third phase will add detailed demographic and facility information used by public health and emergency planners to develop preparedness and recovery plans.

A critical component for the effective support of homeland security efforts in the Sacramento region is the availability of accurate and standardized geographic base features. In addition to the coordinated maintenance of base data, the cooperative has

also pursued the acquisition of high resolution aerial images. To extend the common base framework beyond Sacramento County to encompass the entire Sacramento Urbanized Area, a multi-purpose regional aerial image collection was initiated for 2006.

Under this comprehensive initiative, approximately 1,000 square miles of high resolution orthophotography (straight down) and 600 square miles of oblique (side angle) aerial imagery as well as detailed elevation LIDAR (light detection and ranging) data was collected for the Sacramento Urbanized Area. The images collected through this effort were cooperatively funded from local, state, and federal resources. The Sacramento Urbanized Area photographic base will serve as the common geographic framework for the region.

911 Call Taking, Dispatch, and Reverse 911

Public Safety call taking and dispatch operations are typically resource intensive business functions. Geographic data stored within these systems require dedicated and specially trained staff to maintain address information housed within the CAD (Computer Aided Dispatch) System. Traditionally, this tabular geographic data is maintained with approximate spatial positioning and has very limited geographic value outside of the CAD system.

In an effort to improve efficiency in operating CAD systems in the Sacramento Region, several members of the Cooperative sought to use the jointly maintained GIS data to support daily call taking and dispatch functions. Efficiencies are gained in the shared maintenance within GIS and redundant efforts in individual CAD and records management systems (RMS) are also reduced, saving the region many hours of staff effort and improving the accuracy and timeliness of the data.

City of Sacramento Police, Sacramento County Sheriff, City of Elk Grove Police, Sacramento Regional Fire, and City of Citrus Heights are among the agencies that use the Sacramento Regional GIS address framework to assist in call taking and dispatch.

This coordination and other cooperative efforts in adjoining jurisdictions have assisted the region in the development of the reverse 911 system. By combining standardized GIS address data for the region into a seamless database, public officials and emergency managers can use the reverse 911 system as a resource to quickly inform residents of geographically relevant information. For example, in the event of a flood, residents could be automatically called with recorded evacuation instructions specific to their community.

Flood Plain Management - Flood Inundation Study

The City of Sacramento is part of a natural floodplain and faces tremendous vulnerability to flooding. It arguably has the greatest risk of any major city in the nation as many of the city's nearly 450,000 residents live in high to moderate flood risk areas.

Public officials, flood managers, first responders, Emergency Operation Center staff, and the public use Sacramento's flood inundation and evacuation maps and GIS data to prepare for and respond to flood emergencies. Flood inundation mapping is one part

of the City of Sacramento's unique and forward-thinking Comprehensive Flood Management Plan (CFMP). The CFMP is a comprehensive implementation tool that is used to assist in better decision-making and preparation for major flood events.

Public officials use flood inundation and evacuation map and data in community meetings to help convey flood risk information to residents in a "common sense" format. Public outreach enables residents to make more informed decisions about individual emergency planning and preparedness.

GIS provides sophisticated data processing tools and a rich environment for visualizing spatial information. A GIS-based hydrologic model integrates geographic basemaps and other remotely sensed data with model results. For example, spatial data such as roads, levees, river mile markers, digital elevation models, and aerial photography are used for visualizing flood control structures and flow constraints that are essential to understanding the environment. Important information such as emergency evacuation routes and at-risk populations can also be easily integrated.

Detailed Hypothetical Flood Depth Maps combine complex data elements to efficiently convey risk, populations impacted, road inundation, and how long specific neighborhood areas will take to inundate. Scenarios are carefully chosen to represent realistic situations for a wide variety of locations along levee segments that have historically caused concern or represent areas of high risk.

Map products can quickly communicate complex information to many different user groups. Many users may not have familiarity with the data prior to an emergency flood event and will need to digest the information quickly and make important decisions concerning public safety and property. Unlike other modes of communication, maps can combine sophisticated analysis and large amounts of data and convey that simply.

Critical infrastructure and vulnerable population data stored within the City's Enterprise GIS, Sacramento County GIS, and a variety of other GIS and data management systems throughout the region are compiled for the impacted areas. This combined data is used to identify and develop rescue and evacuation areas, evacuation routes, shelters, and resource management. A variety of map projects, analysis tools, and hard copy maps are produced to facilitate on-the-fly analysis and field assessments in the event of a flood emergency. Emergency planners and operations staff use these tools to both develop specific action plans and respond to events as they unfold.

If an event were to unfold very quickly and technical support was delayed, hard copy hypothetical flood inundation maps could be used to determine evacuation routes, rescue areas, populations impacted, and location of critical facilities.

Given the threat that a major flood event poses for the Sacramento area and the devastating impact that it could have on lives and property, public officials and emergency responders have taken advantage of innovative analysis and technology to better prepare and respond to such an event.

The use of advanced GIS tools resulted in improvements in data entry to hydrologic models and the ability to model very large areas with a larger number of levee breach scenarios. The storage of inundation and evacuation data in a spatial enabled relational data model enables Emergency Operations Center (EOC) GIS staff to easily and quickly navigate appropriate hypothetical levee breach data with other relevant spatial and non-spatial data from a single environment. The use of professional GIS tools allows for high quality cartographic products that can convey hypothetical levee breach scenarios clearly for use by emergency response personnel and the public.

Flooding and the threat of a flooding emergency have historically been an issue for the Sacramento area. The City of Sacramento takes this threat seriously and continues to look for innovative ways to prepare for and respond should a flood event occur.

Emergency Operations Center Support

The city has been using GIS in its Emergency Operations Center since the 1990s. Sacramento City and Sacramento County GIS have formed an effective partnership to provide GIS services at the City/County of Sacramento Emergency Operations Center. Both the city and county regularly participate in simulated and real activations.

EOC GIS staff support functions fall under the direction of the Planning Section Chief. GIS staff integrates Situation Status information necessary to develop a common operational picture for senior leadership and other emergency responders. The focus of the GIS team is to develop an integrated picture of an emergency event. The unit consolidates and analyzes information coming into the Planning and Intelligence section from other functional sections of the EOC.

The GIS unit is composed of different functional roles and is modular. In a small event, one person could fill all or more than one role and in a big event several people could staff the same role. GIS will support the Planning Section Chief in providing the EOC with such products as a Situation Status Displays, Incident Action Planning, Manager Briefings, Analysis, and other Operational Unit Support as directed by the Planning Section Chief.

CONCLUSION

GIS technology is critical in effectively supporting our nation's homeland security efforts to protect life, property, and infrastructure. Regional coordinated development and maintenance of geographic information can assist local agencies in more effective delivery of daily services and better prepare for and respond to major disasters. The City of Sacramento and the Sacramento region as a whole have had great success in using GIS for more effective decision-making and improved service delivery in mission critical public safety systems.

Contributed by Maria MacGunigal, GIS Manager, City of Sacramento.

Integrating GIS in Emergency Management Situations
City of Seattle, Washington

The City of Seattle has actively used GIS in emergency management since the start of its enterprise GIS in 1989. During this time it has helped the city manage major incidents and exercises like the 1999 World Trade Organization protests and the 2001 Nisqually Earthquake. While large incidents tend to get the most attention, GIS also helps quietly behind the scenes before and after incidents as a tool to analyze hazard risks, train responders, and recover from events.

Seattle Public Utilities (SPU, the business owners of the enterprise GIS) and Seattle Emergency Management (SEM) have had a strong working relationship since 1995, when SEM hired a GIS-trained Information Technology coordinator. Small jobs and analysis can be handled in-house. Large jobs are sent to SPU. SEM created a formal GIS Analyst role in the Emergency Operation Center (EOC) that is staffed by SPU when the EOC activates. For large incidents, the position can be augmented into a small team. The GIS analyst reports to the SEM Information Technology coordinator who functions as the head of the Situation Unit.

Recently, many department operation centers and other jurisdictions have acquired GIS. Coordinating with these organizations has proven challenging given the lack of established plans and standards for emergency GIS.

SEM has received some funding for GIS bundled into projects with a broader scope. For example, it acquired WebEoc, a commercial crisis information management system. This software has a GIS component. Previously, proposals have been made to improve GIS capacity through the local Urban Areas Security Initiative (UASI) process, but the proposals were turned down at the regional level. UASI is a program funded through the DHS.

Lessons learned include:

- Integrate GIS into everyday emergency management functions.
- Build GIS skills into the emergency management staff and build awareness of emergency management into GIS staff.
- Make GIS part of a “Situation Unit” (part of the Incident Command System) that is a “full service” information management group within an EOC. It includes experts in AV systems, communications, data warehousing, and analysis and policy specialists.
- Create a regional GIS plan that pre-defines “emergent” data layers that do not exist prior to an incident. For example, create “staging areas.” Make sure all organizations agree on data definitions. Assign responsibilities for defining the geometry of these areas to specific organizations and/or roles. Create a common symbology for these areas. (Note: several national efforts are underway in this area).

- If possible, take advantage of new GIS technology like ESRI's SDE and ArcWeb Services. SDE allows edits to occur while users view the data. This functionality is critical in a rapidly changing situation. Web services seem a better way to distribute maps over the web than ArcIMS. They are less picky about edits to the underlying datasets.
- Build GIS into applications, but do not rely on an application to provide all the answers. Each incident is unique. GIS analysts will be needed to tweak the most well constructed template.
- The GIS analyst should really know the data and be able to articulate appropriate use of spatial data to non-GIS users.

Contributed by TJ McDonald, IT Coordinator, Emergency Management Section, Seattle Police Department.

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